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ALGORITHM TO COMPENSATE SKEW FOR RIGID MEDIAS

HP INC

Algorithm to compensate skew for rigid medias

Title

Algorithm to calibrate and compensate skew for rigid medias

Abstract

The world of printing on rigid materials often demands skew requirements that are difficult to achieve in non-true flat belt printers. This requirement has its origin in the need of customers to optimize printing processes, saving post-processing and media waste.

Often, clients must print full bleed or leave blank margins if they want to have an image printed on all support. Both strategies can be avoided if the printer has a good skew compensation strategy with the consequent savings for the client.

Total skew on images printed on rigid medias is the sum of three contributors: media orthogonality, media load accuracy, and the alignment of the print axis and the media advance direction. This last contributor is a parameter particular for each printer since is caused by its manufacturing tolerances.

The scope of this invention is correcting the last contributor by using and algorithm to mitigate this defect using a calibration process and a compensation when printing.

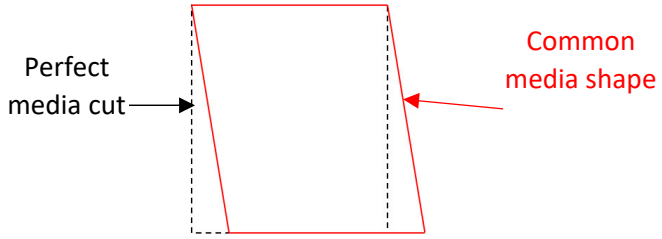
Roll to roll printers have some strategy to correct the media advance direction by using some fiducials that are printed next to the image and used in real time to reposition the image. This procedure needs to be done live since media advance direction changes as the material is loaded into the printer.

Hybrid printers based on a belt conveyor can optimize this strategy using a different approach. Media advance direction is a constant parameter due to the alignment of structural parts, that can be calibrated once and applied straight to each plot, resulting in an optimized printing process and no downtime.

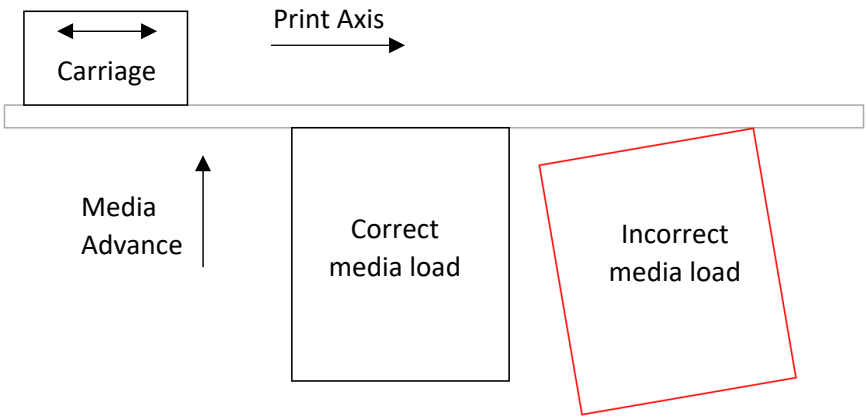
Problems solved

Skew is the misalignment of the edges of the printed image and the edges of the substrate. On hybrid printers as the R-Series ones, the main contributors for the skew are:

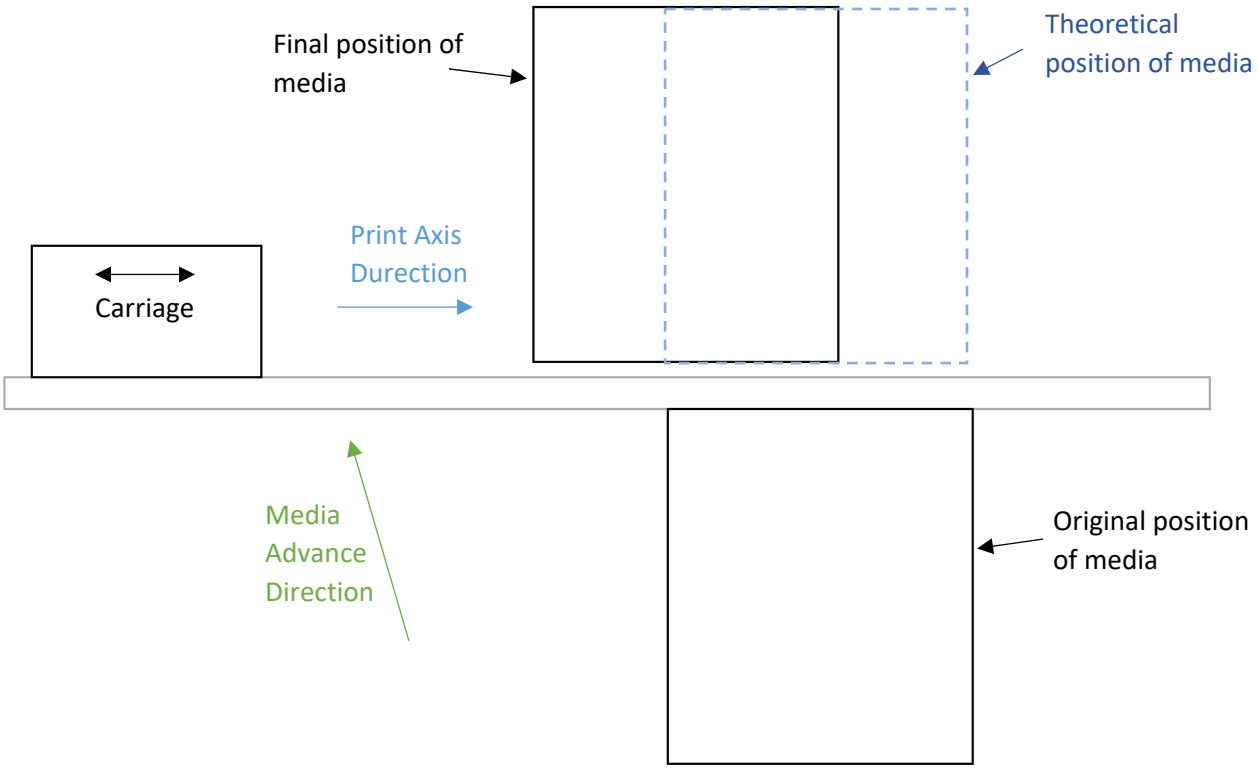
- Substrate orthogonality
  When loading a media into the printer we have to use one edge of the substrate to align it. If the other edges are not perpendicular to the one used as a reference, the edges of the image will have a skew due to this lack of orthogonality.



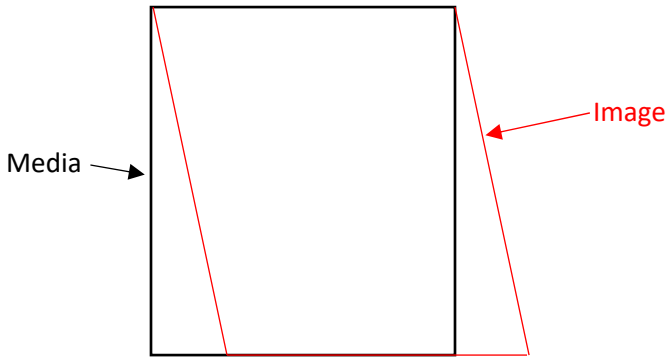
- Media Loading Accuracy
  The media load procedure for R-Series printers requires to position the media (front edge) against a reference attached to the printing axis. If the media is not positioned accurately, skew may appear during printing.



- Alignment of the print axis and the media advance direction
  R-Series printers us a belt conveyor to manage media into the printer. This means that the loaded substrate is fixed to this belt.
  As any mechanical system, the manufacturing tolerances of the belt conveyor and the printer in general force the media to have an advance direction not perpendicular to the print axis, and so, the image printed has a skew on the lateral edges. On every media advance there is a forward movement but also a lateral one.
  Since this is an effect caused by mechanical tolerances is different and unique for each printer and can be calibrated.



As a result.



The algorithm proposed on the disclosure solves the skew caused by the alignment of the print axis and the media advance direction.

Prior solutions and limitations

There is no prior solution to solve this problem.
The workaround proposed to mitigate this skew was to recommend loading the media as good as possible to avoid the loading skew, applying wider full bleed extra margins to the image, or using bigger substrates and a post cutting process.
None of these alternatives involve a benefit for the client.

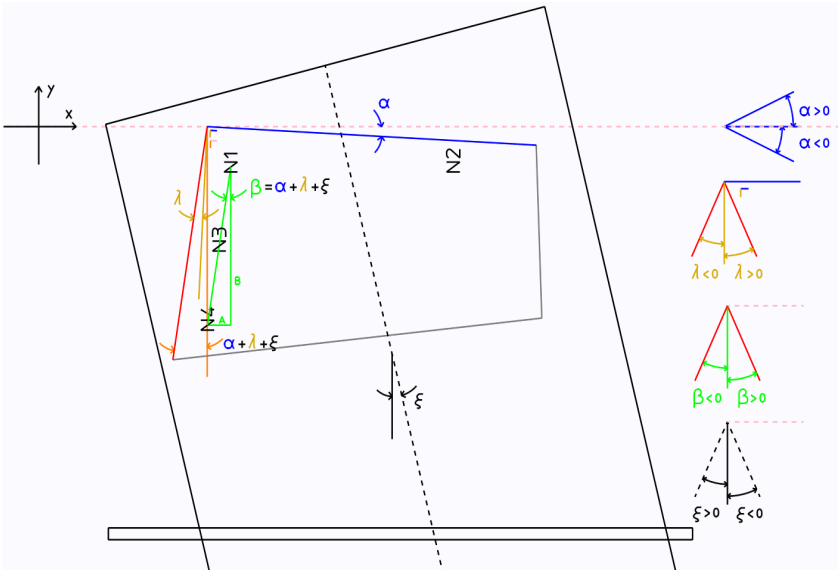
New solution description

The solution proposed on this disclosure consists of a calibration process that has to be done on every printer. This process is automated using the printer functionality and has to be done at factory or after replacing any part involved in the media handling into the printer.

The result of the calibration process is a parameter that con be stored in the printer firmware and used later to adjust the image when printed.

The calibration process consists in an automatic diagnostic that has these steps:

- 1st step. Printing
  User must print a diagnostic plot in one media sheet.
  This diagnostic plot consists on printing some images at a certain distance from the media edges; first two images are printed near the leading edge of the media, and the others are printed along the lateral edge.
  The algorithm used on this step consists on:
  - User:
    - makes a media load using the media specified in the diagnostic manual
  - Printer:
    - Advances the media to the printing position
    - Detects the lateral edge of the media with the optical sensor installed at the carriage
    - Prints an image with a particular pattern. This pattern is printed at 10mm from the lateral edge of the media.
    - Prints the same pattern next to the opposite edge and at a distance of XXXXmm from the first image printed.
    - Advances the media 400mm forward
    - Detects the lateral edge of the material with the optical sensor installed on the carriage
    - Prints another pattern at 10mm from the lateral edge
    - Advances the media forward 400mm
    - Print another pattern at 10mm from the lateral edge detected

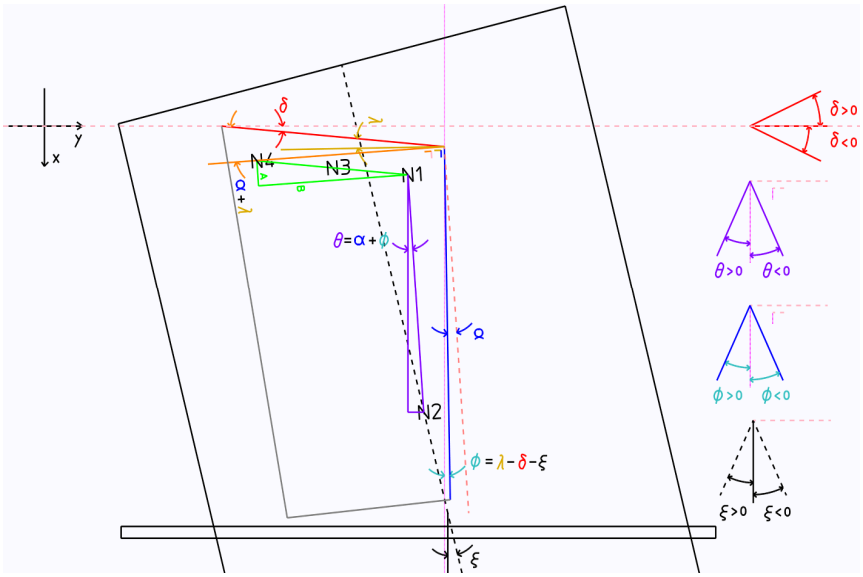


- 2nd step. Measuring the images printed

  After printing the patterns on the media, users has to reload it into the printer and the diagnostic will then measure the real distances from the edges to each pattern printed. Those measures will be user lately to calculate the printer parameter.

  The algorithm used on this step consists on:

  - User:
    - Takes the media printer at the printer output
    - Reloads de media with the printed side up, but rotated 90 degrees clockwise
  - Printer:
    - Advances de media to the theoretical position of the pattern row
    - Measures the patterns location from the lateral edge using the optical sensor
    - Advances the media to the theoretical position of the last pattern
    - Measures the pattern locations from the lateral edge using the optical sensor.



- 3rd Step. Calculating the alignment of the print axis and the media advance direction

  Pattern printed in the diagnostic plot consists on a geometry similar to a letter “N” rotated 90 degrees. These figures allow the printer to read it using the optical sensor and calculate its center of gravity. This point will be used to locate the pattern from the edge and measure it distance.

  The relative position between the patterns is known, and the relative position of each pattern to the edges can be measured, so we can calculate the skew forced by the media advance direction using the equations shown below:

$\alpha = \tan^{-1}\frac{f-e}{d}$	$\beta = \alpha + \lambda + \xi$
$\beta = \tan^{-1}\frac{a}{b}$	$\varphi = \lambda - \delta - \xi$
$\delta = \tan^{-1}\frac{g-i}{l}$	$\theta = \alpha + \varphi$
$\theta = \tan^{-1}\frac{c}{d}$	$\xi = \frac{\beta - \delta - \theta}{2}$

Once this parameter is known it can be stored in the printer and later used to compensate this alignment while printing without having downtimes to relocate the image on the media.

Advantages of our invention

The advantages of the solutions are:

- Eliminate the skew produced by the lack of perpendicularity of the media advance direction and the printing direction avoiding a postprocess
- Avoid post processing cost of cutting media after printing or wasting ink with bigger full bleeds
- Customers can print more challenging images with no extra effort or costs
- Printing time is not affected by the compensation algorithm because there is no need of checking the media position

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